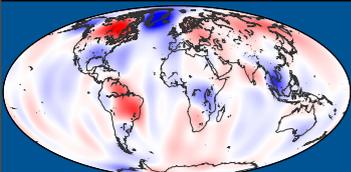


Summary of the 2012 Global Geophysical Fluid Center Workshop

T. van Dam (Uni. Lux), J. Ray (NGS/NOAA), X. Collilieux (IGN)



IGS 2012

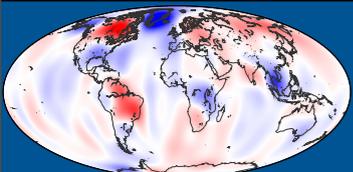
23-27 July, 2012

Olsztyn, Poland



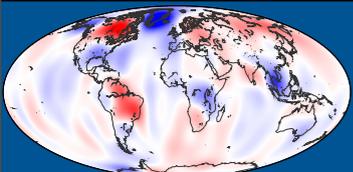
Introduction

- Review the history of the GGFC
- Discuss the 2012 Workshop
 - Highlight some presentations from the Workshop
 - Review recommendations



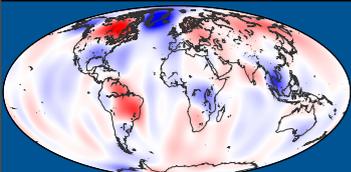
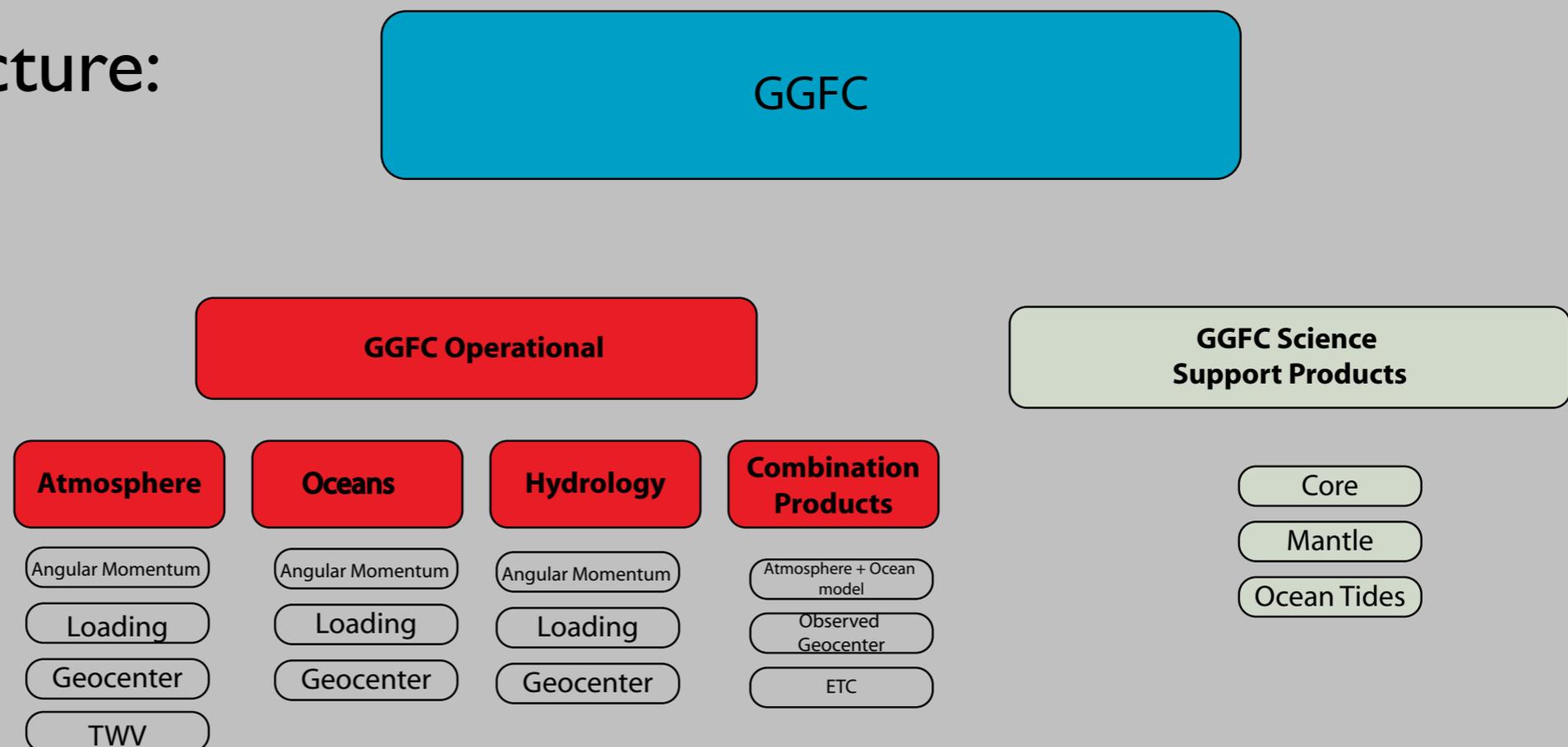
Global Geophysical Fluid Center (GGFC)

- International Earth Rotation and Reference Systems Service (IERS)
- GGFC Established January 1, 1998 with the goal of expanding IERS's services to the scientific community
- Originally composed of 8 Special Bureaus supplying products related to an environmental or solid Earth fluid in response to community requirements
 - Atmosphere, Hydrosphere, Oceans, Tides, Mantle, and Core
 - Loading and Gravity/Geocenter
- Products: angular momentum, loading, geocenter, Earth models, tidal models, ice models, etc.



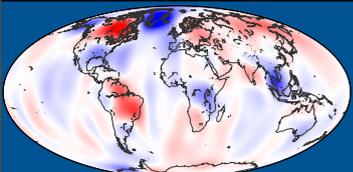
Global Geophysical Fluid Center

- 2009: IERS Directing Board voted to restructure the GGFC primarily to:
 - allow for the establishment of operational products
 - allow for the incorporation of new products
- Current Structure:



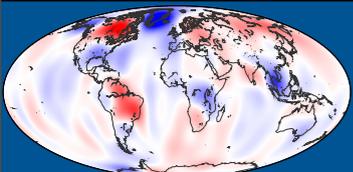
Global Geophysical Fluid Center

- Currently there are four operational entities:
 - Special Bureau for the Atmosphere (SBA, Chair, D. Salstein)
 - Special Bureau for the Oceans (SBO, Chair, R. Gross)
 - Special Bureau for Hydrology (SBH, Chair, J. L. Chen)
 - Special Bureau for Combination Products (SBCP, Chair, T. van Dam)
- SB's provide:
 - data and models of geodetic effects (rotation, gravity, and deformation) driven by the temporal redistribution of the Earth fluids
 - AND information needed for geodetic observations that rely on the state of the fluids (core, mantle, tides)



GGFC Workshop

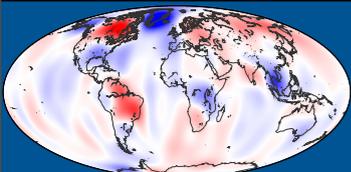
- Workshops are organized to allow an opportunity for the Special Bureau Chairs, the GGFC Product Centers, and the GGFC user community to review the structure and data holdings of the GGFC
- GGFC Workshop Vienna, 20 April 2012
- The specific goal was to assess the errors in current environmental models and to solicit ideas for overcoming these limitations so that the data could be reliably used in geodetic and geophysical data analysis
- Workshop was attended by 30 scientists from the geodetic data analysis community and the environmental research community



GGFC Workshop

- Classes of presentations
 - New operational products
 - Comparison of models with geodetic observations
 - Current issues and future challenges for the GGFC and geodetic community
- The program and presentations from the workshop are available here:

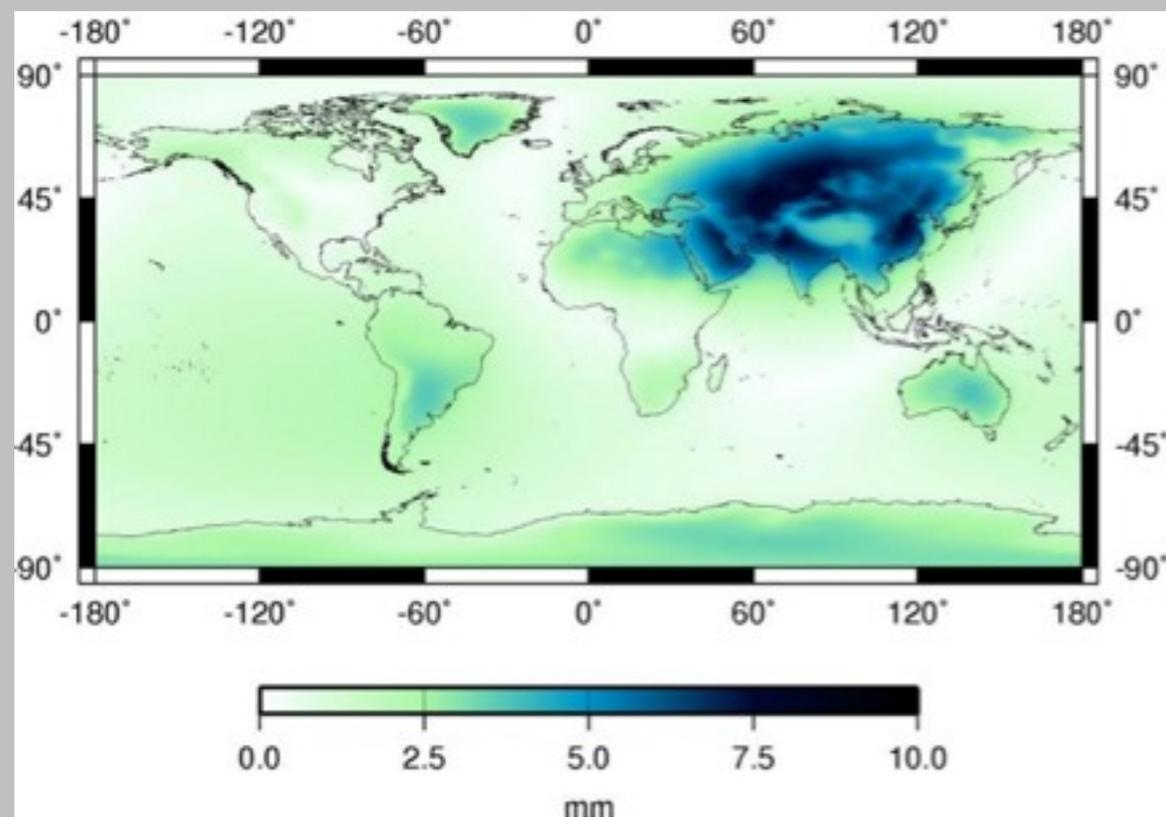
<http://www.iers.org/ IERS/EN/Organization/Workshops/ Workshop2012.html>



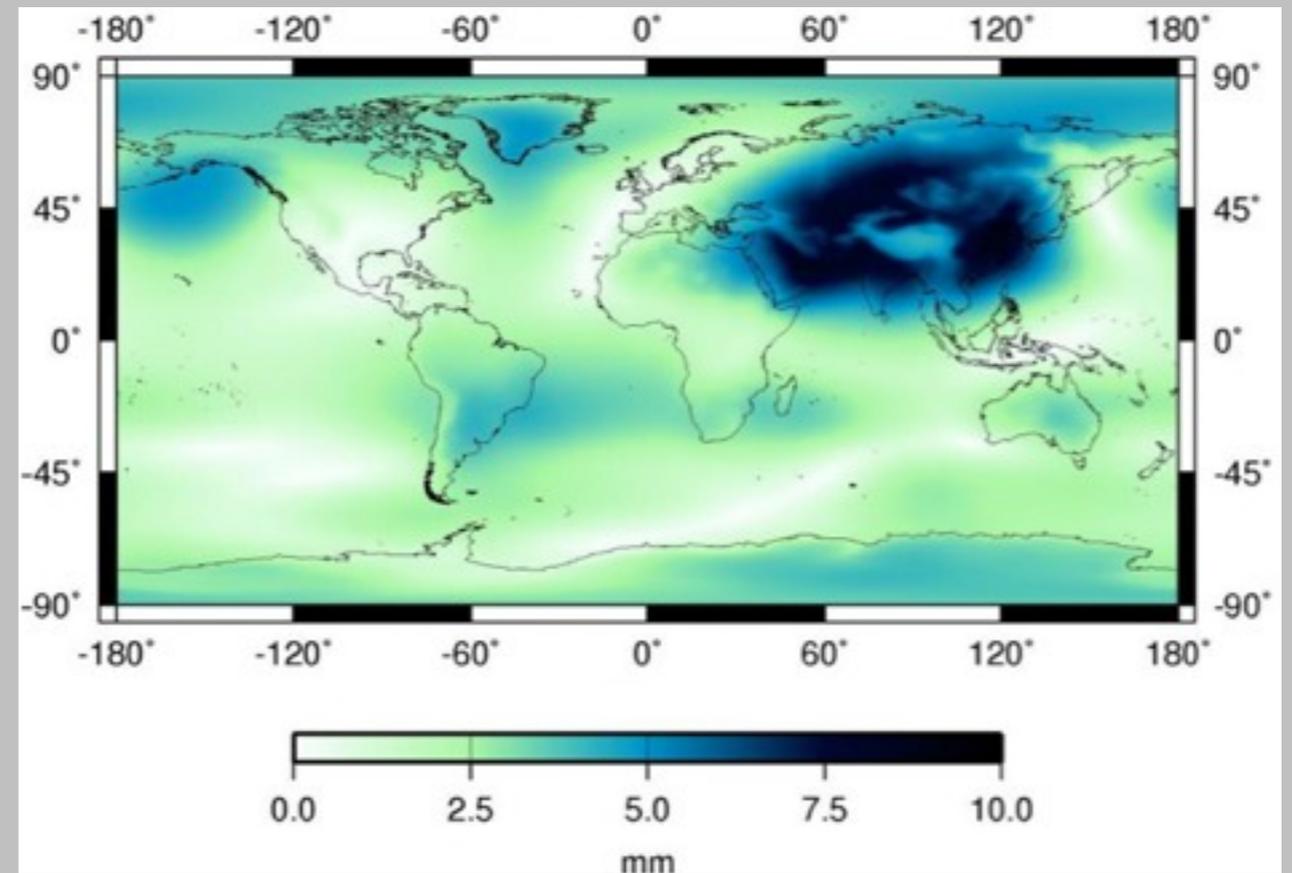
GGFC New Operational Products

- J.-P. Boy, “High-resolution models of surface displacements caused by atmospheric, oceanic and hydrological loads”
- MOG2D models the dynamic response of the ocean

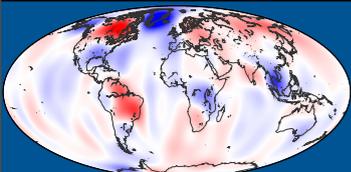
up, ECMWF IB



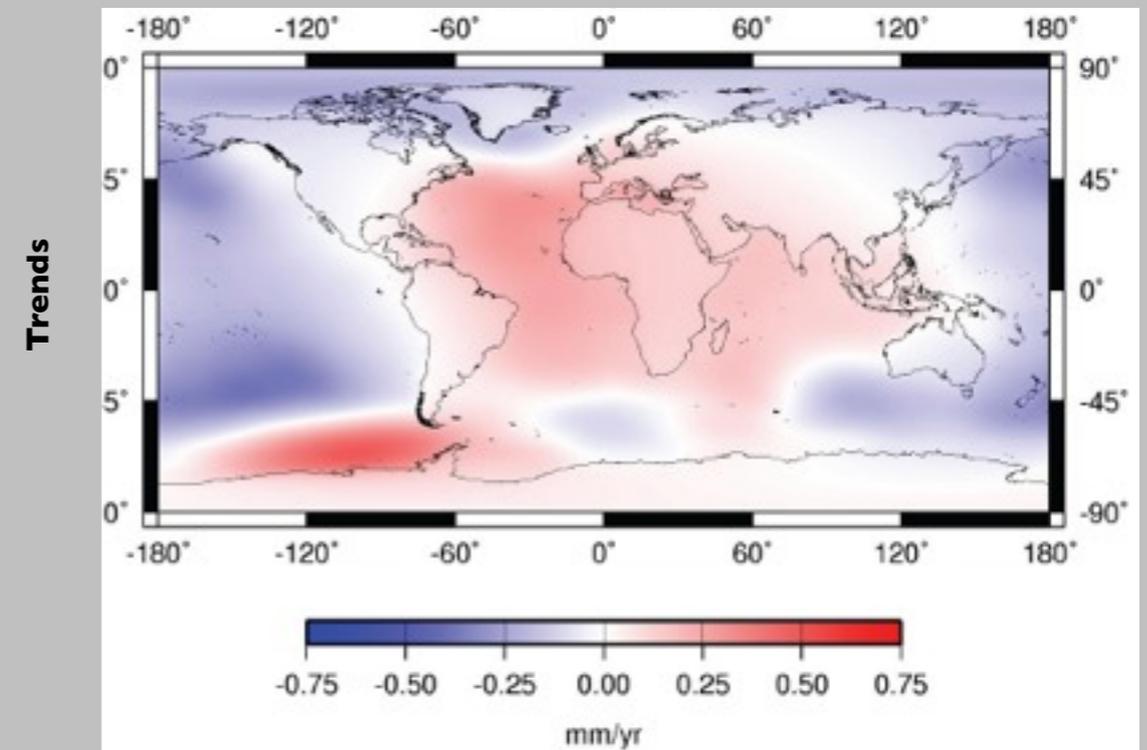
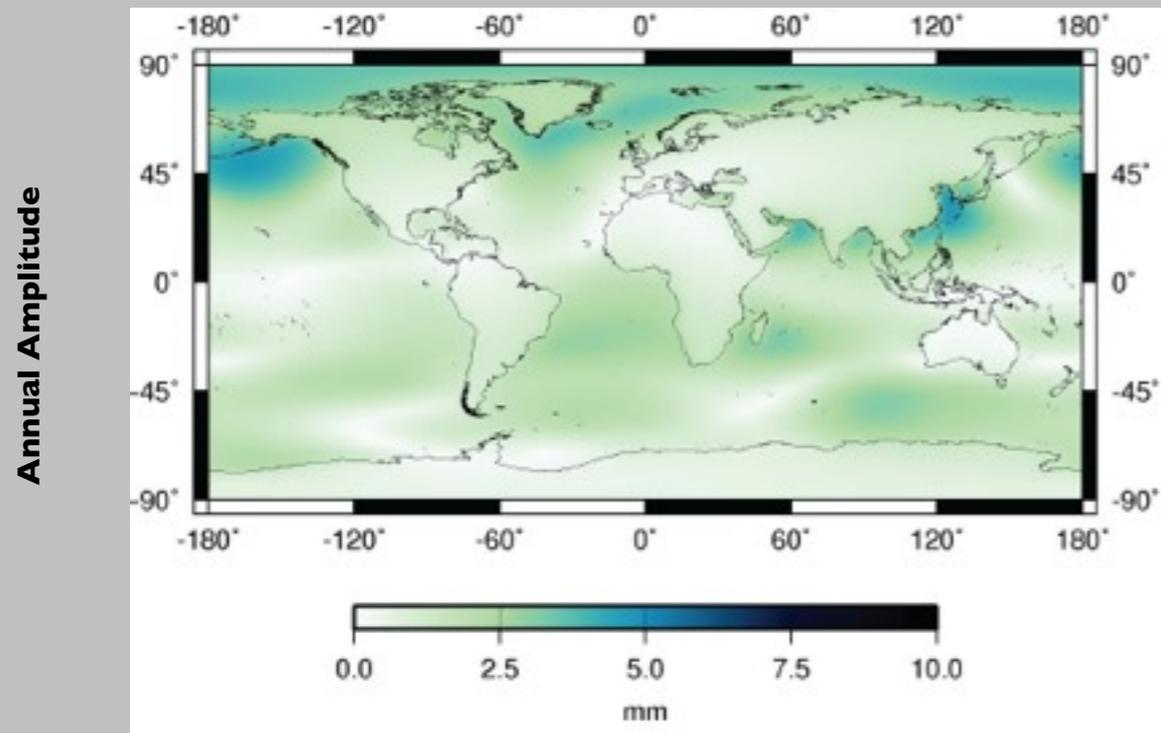
up, ECMWF MOG2D



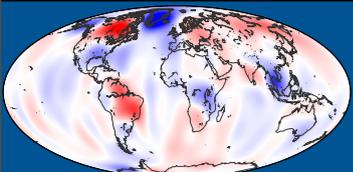
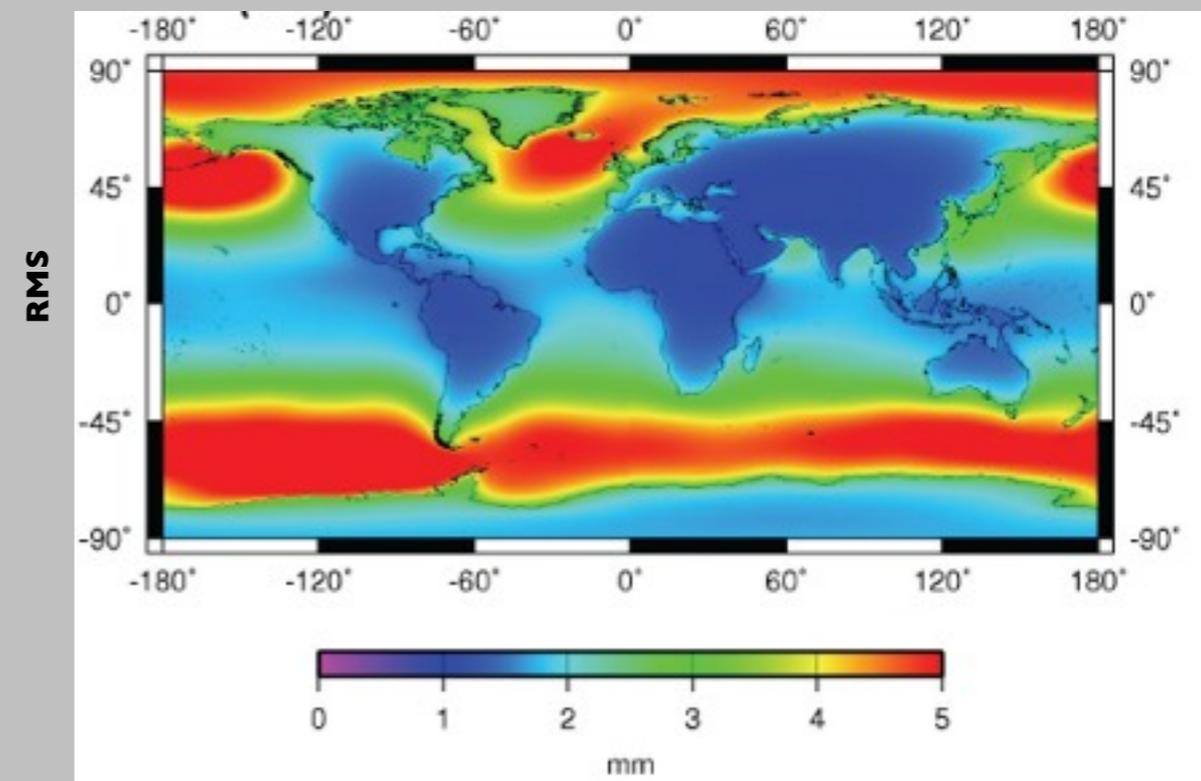
Annual Amplitudes of the Up Component



GGFC New Operational Products

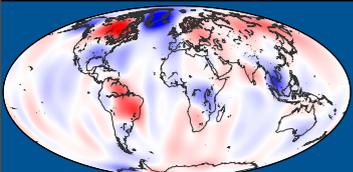


- **Differences** between ECMWF/IB combination and the ECMWF/MOG2D combination



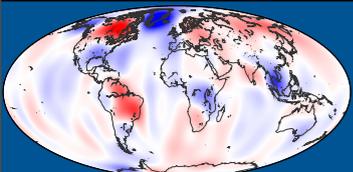
GGFC New Operational Products

- J. Böhm et al., “Atmospheric effects in space geodesy: plans and perspectives”
 - Atmospheric angular momentum (ECMWF)
 - Atmospheric loading (ECMWF)
 - Atmospheric gravity corrections (ECMWF)
 - Atmospheric delays (ECMWF)
- D. MacMillan, “Mass Loading Products at NASA GSFC”
 - Atmospheric loading (NCEP)
 - Hydrological loading (GLDAS)



Comparison of Models with Observations

- J. Ray et al., “Consistency of Crustal Loading Signals Derived from Models & GPS: Inferences for GPS Positioning Errors”
 - 706 stations; IGS weekly combined; required that more than 100 observations were available
 - Percent of stations with lower RMS after removing loading:
 - $dn = 72.0\%$; $de = 62.9\%$; $du = 87.4\%$
 - Percent of stations with lower annual amplitude after applying loading:
 - $dn = 70.7\%$; $de = 59.3\%$; $du = 87.1\%$



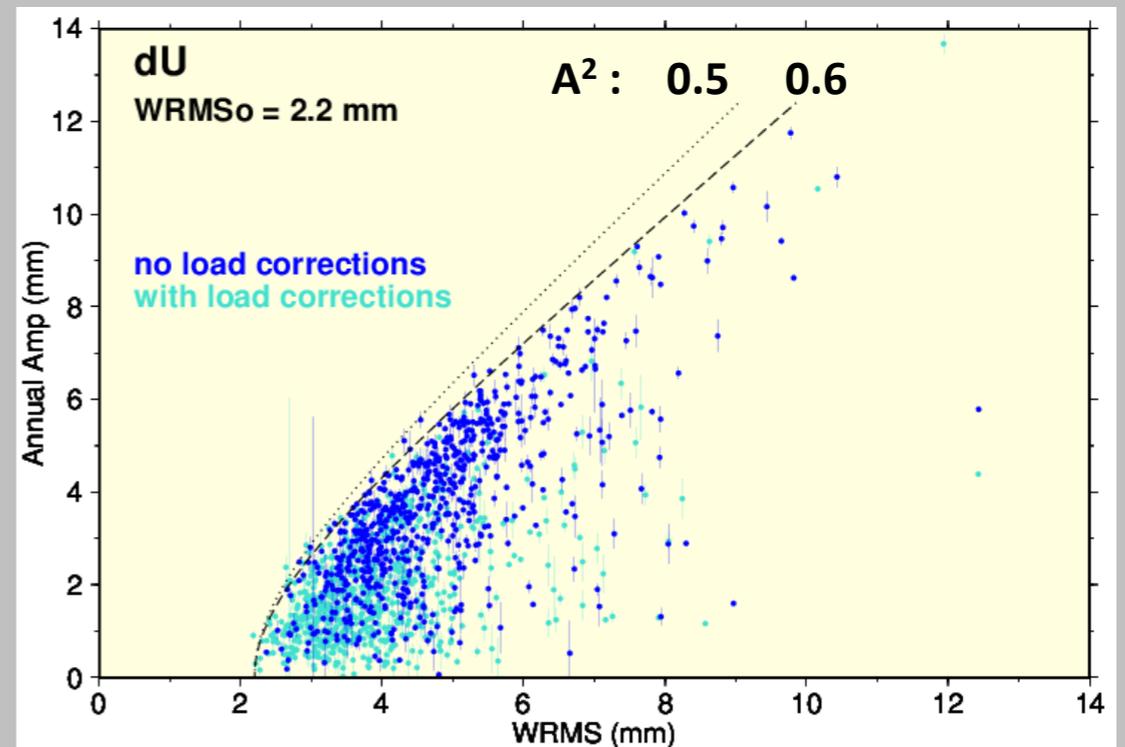
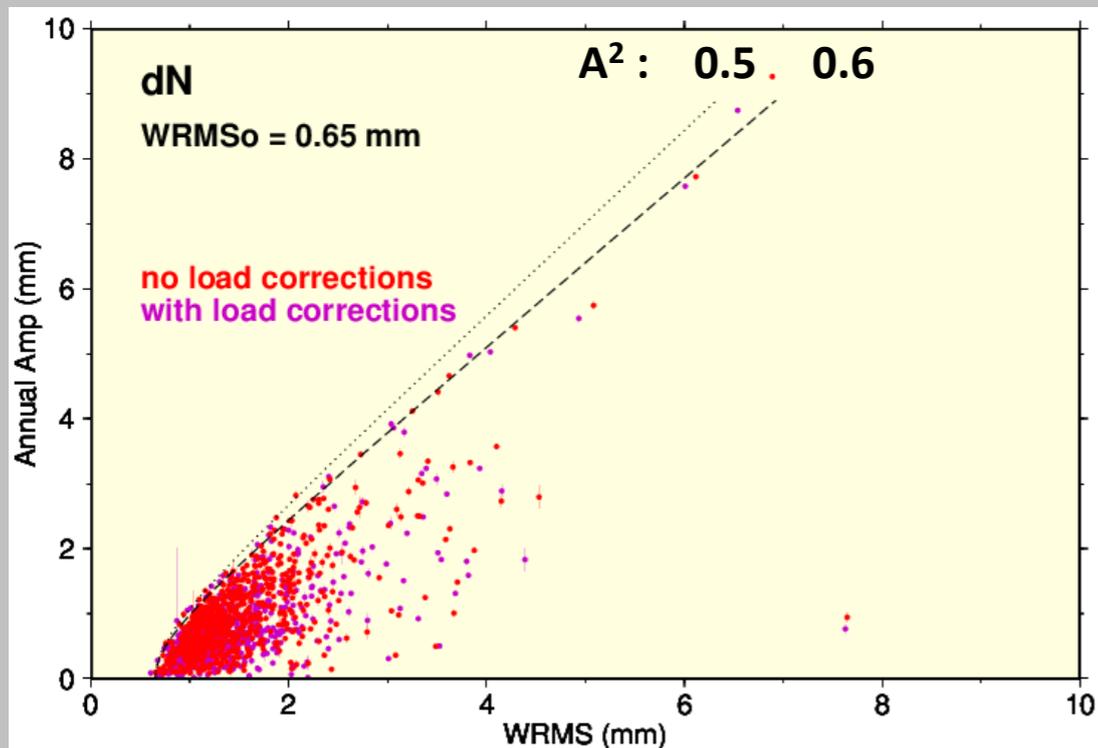
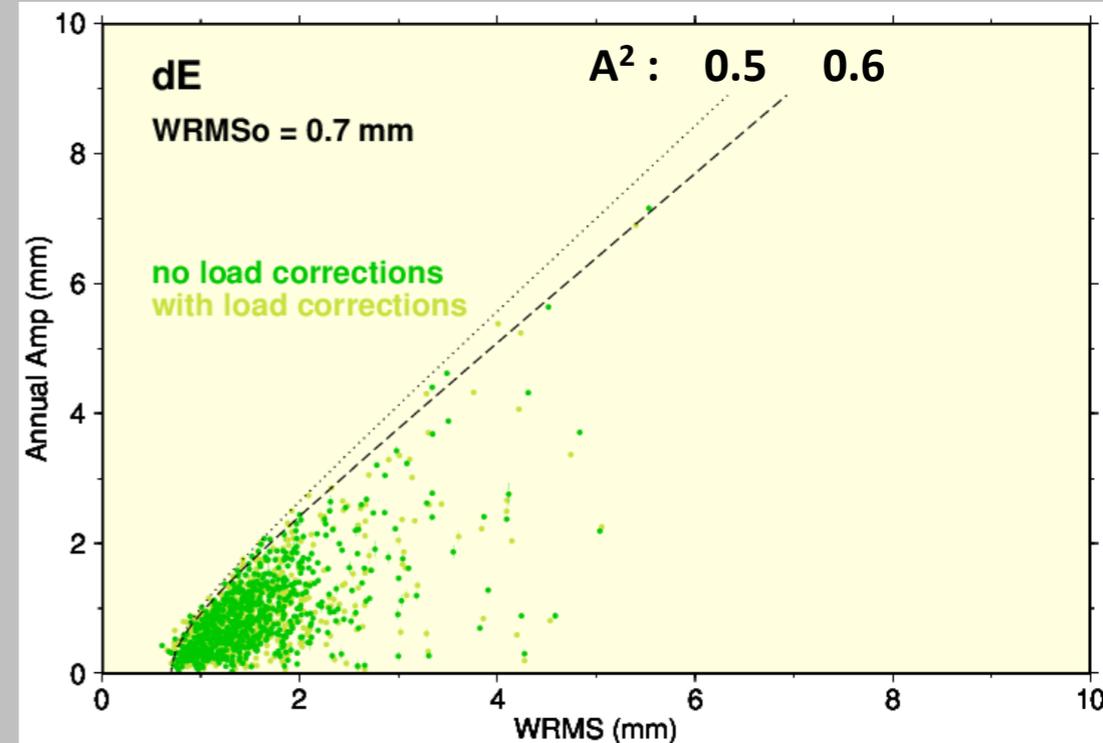
Comparison of Models with Observations

$$WRMS^2 = WRMS_o^2 + (A_i Ann_i)^2 + WRMS_i^2$$

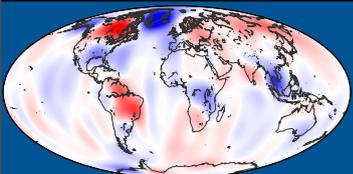
$$WRMS_o^2 = \text{Globally averaged error floor}$$

$$Ann_i = \text{mean Annual Amplitude, } A_i = 0.6$$

$$WRMS_i^2 = \text{local site specific errors}$$



J. Ray et al., Consistency of Crustal Loading Signals Derived from Models & GPS: Inferences for GPS Positioning Errors



IGS 2012

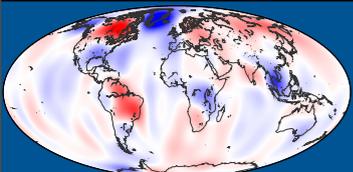
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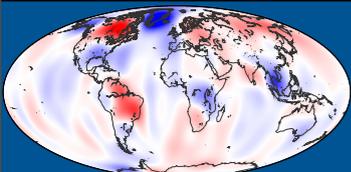
Comparison of Models with Observations

- E. Pavlis and M. Kuzmich-Cieslak
 - preliminary test of ATML effect at the observation level on SLR data
 - inconclusive
 - they expected an effect because SLR uses multi-day arcs and because SLR is additionally affected by the attraction of the mass
- R. Dach, presentation this session
 - Test of ATML effect at the observation level
 - Concludes that ATML needs to be applied at the observation level
- IERS Call:
 - for analyses with and without ATML at the observational level to determine the effect on surface displacements and ITRF



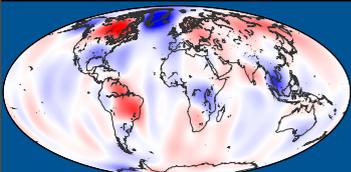
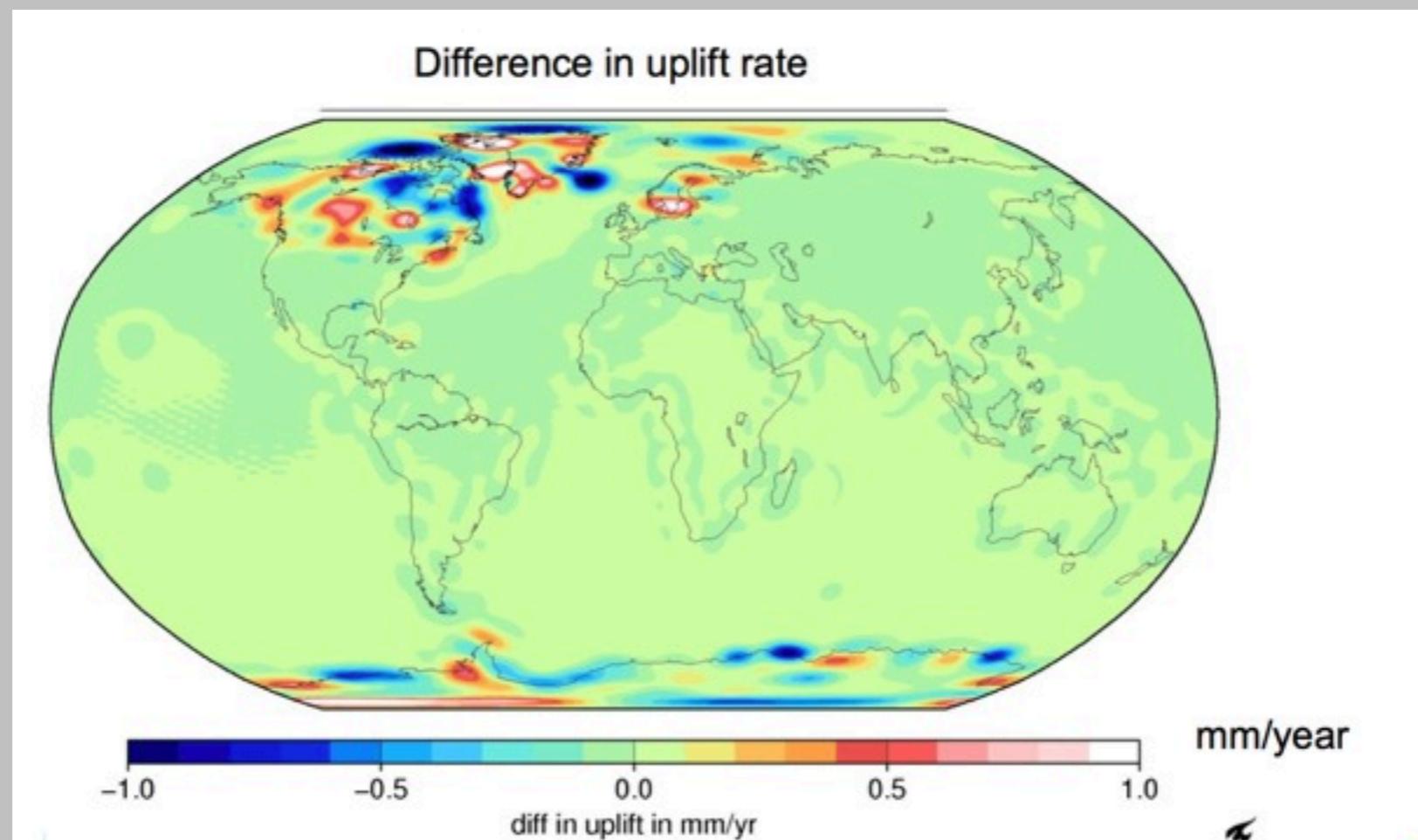
Issues and Future Challenges

- M.Thomas, “On the challenges of developing a mass conserving system model”
 - Should be THE priority for the GGFC
- R. Dach, “Mitigation of unmodelled non-tidal atmospheric pressure loading into parameters of a global GNSS solution”
 - Still being debated



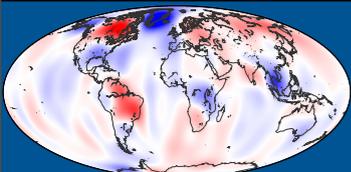
Issues and Future Challenges

- W. van der Wal, “Uncertainties in models for glacial isostatic adjustment”
- Propagation of uncertainties in viscosity model, ice load history, sampling, etc.



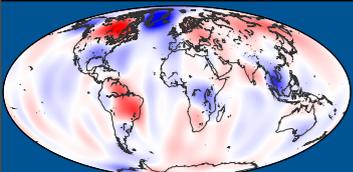
Highlights and Recommendations

- Investigate forming intra-fluid weighted combined products to investigate ways to quantify the errors in the mass models
- Promote the development and use of dynamic barometer models and products
- Promote sub-daily product sampling (3hr or shorter)
- Move toward adopting common product formats
- Reduce latency of products required for operational use
- GGFC angular momentum components should lead an effort to review and elaborate procedures and algorithms to compute EOP excitations from geodetic time series
- Investigate the large discrepancies in surface hydrology EOP excitations using new models; Biases in the models might degrade EOP products



Highlights and recommendations

- GGFC should work with the technique services and greater geodetic community to determine the utility of load corrections in geodetic data reductions
- the effects need to be much better quantified using a sound statistical basis considering the SNR for the loads as a function of sampling interval of the relevant parameters
- **Global mass conservation**
 - global mass conserving models do not exist for geodetic applications
 - current solution is to sum the different models => inconsistencies
 - only models (e.g. ocean and hydrology) forced by the same atmospheric model and that consider continental discharge to the oceans should be combined to compute total effects



Highlights and recommendations

- Simultaneously with these efforts, we need a much better understanding of the nature and magnitude of internal measurement errors by all space geodetic techniques, especially at short temporal samplings, if these are to be used to evaluate fluid-based load models

